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PRODUCTION OF SYNTHESIS GAS FROM BIOMASS AND PLASTIC WASTE USING A UPDRAFT GASIFIER

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ABSTRACT

The capability of blend gas creation from biomass and plastic waste chip material by spending draft type fixed bed gasification innovation is examined. The reason for this examination is to explore the syngas generation utilizing biomass and plastic waste chip material in the updraft type fixed bed gasification framework. It is discovered that biomass and the plastic waste material can be effectively changed over to create the syngas comprising of carbon monoxide (CO), carbondioxide (CO_2), oxygen (O_2) hydrocarbon (HC) and water vapours.

In this project, synthesis gas is produced by using the biomass materials using coconut shells, castor husk, sugarcane bagasse, rice husk and plastic waste with help of updraft type fixed bed gasification technology. In our investigation, coconut shells produce more synthesis gas.

KEYWORDS: Calorific Value, Coconut Shell, Castor Husk, Sugar Cane Bagasse, Plastic Waste, Material, Rice Husk, Gas Production Rate, Gasification Efficiency, Gas Flow Rate & Pressure Gage

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Original Article

1. INTRODUCTION

Petroleum products which meet the greater part of the world vitality request today are being exhausted quickly. Likewise their ignition items are causing worldwide issues, for example, a nursery impact, ozone layer exhaustion, corrosive downpours and contamination, which are presenting an extraordinary risk for our condition and in the end, for the absolute life on our planet [1]. So we have to build up an elective fuel for the most widely recognized fuel like oil, diesel and LPG. In our examination, we have presented the maker gas as another elective fuel created by methods for biomass gasification. Gasification is a setup innovation, the first commercial use of which goes back to 1830. Amid world War II, biomass gasification framework seemed everywhere throughout the world to control vehicles to keep essential transport framework running. Gasifier is the gear that changes over biomass into maker gas. The most regular crude material is wood chip and other waste from wood industry, coconut shell, civil strong waste, and plastic material etc. Biomass is the fourth biggest wellspring of vitality on the planet and it is likewise an inexhaustible rich and a possibly supportable real hotspot for hydrogen creation later on [2]. Biomass can be handled from multiple points of view including a few thermo substance and organic procedures, for example, gasification, pyrolysis, hydrolysis and maturation to push use gases, fluids and solids. Pyrolysis and gasification are two powerful change techniques to deliver hydrogen-rich gas from biomass, which can be additionally, steam transformed or gone through an impetus to acquired higher virtue floods of gas [3]. Besides pyrolysis and gasification process condition can be advanced to expand the yield of gas, fluids or roasts.

Stages response frameworks have been utilized in the gasification procedure to build the hydrogen focus in the gasification procedure to expand the hydrogen fixation in the item stream. The procedure of gasification changes over natural material into carbon monoxide, carbon dioxide and hydrogen gas [4]. The procedure is widely utilized on mechanical scales for the age of power from fuel. The gasification venture into city, strong and dangerous waste transformation plant operators have the chance to preserve asset and breaking point risky outflow procedure, for example, gasification gives progressively natural well disposed of, a monetarily valuable technique for delivering vitality [5]. The motivation behind this examination is to explore the blend gas syntheses of plastic-squander in the updraft type fixed bed gasification framework. It is discovered that plastic-waste can be effectively changed over to produce the combination gas comprising of carbonmonoxide, carbon dioxide, hydrocarbon, hydrogen sulfide oxygen and water vapor [6]. The execution of the updraft type fixed bed gasification framework is assessed as far as the piece of syngas and the rate of Carbon monoxide creation.

2. MATERIAL TO BE USED

The Gasification of biomass and plastic Waste material was done in an updraft type reactor. Biomass and plastic waste material with various structures were put in a first stage pyrolysis reactor and this mix was pyrolyzed at a higher temperature. An investigation was performed with biomass and double blend with plastic waste material [7]. The high unstable substance of plastics is identified with the higher tar development contrasted with other feedstock, for example, biomass and coal. The tar arrangement component particularly its assessment in the response condition in plastic waste gasification fundamentally varies from those of coal and biomass for the most part because of the diverse piece of the volatiles delivered in the pyrolysis step [8]. Biomass can be dealt with from different perspectives including a couple of thermo substance and natural methods, for instance, gasification, pyrolysis, hydrolysis and development to push use gases, liquids and solids [9]. Pyrolysis and gasification are two amazing change systems to convey hydrogen-rich gas from biomass, which can be moreover, steam changed or experienced a catalyst to gained higher righteousness surges of gas [10]. The valorization of waste plastic by gasification forms has been tended to following a wide scope of procedures and seeking after the generation of union gas of various arrangement and potential applications [11]. Anyway, a few investigations of gasification with biomass and plastic waste material have been completed. Among them, direct gasification is the most concentrated one with elective prompting a gas result in moderately low warming quality[12].

2.1. Biomass Material Representation

2.1.1. Before Gasification of Biomass Material

Figure 1: Castor Husk.

Figure 2: Rice Husk.

Figure 3: Coconut Shell.

Figure 4: Sugar Cane Bagasse.

Figure 5: Plastic Waste Material.

2.1.2. After Gasification of Biomass

Figure 6: Ash of Castor Husk.

Figure 7: Ash of Rice Husk.

Figure 8: Ash of Coconut Shell.

Figure 9: Ash of Sugar Cane Bagasse.

Figure 10: Ash of Plastic Waste Material.

3. CHEMISTRY OF THE GASIFICATION PROCESS

3.1. Drying Zone

The principle procedure is of drying of wood. Wood entering the gasifier has a dampness substance of 10–30%. Different examinations on various gasifiers in various conditions have appeared on a normal the condensate framed is 6–10% of the heaviness of gasified wood. Some natural acids additionally turned out during the drying procedure. These acids offer ascent to the erosion of gasifiers.

3.2. Pyrolysis Zone

Wood pyrolysis is a mind-boggling process that is as yet not comprehended. The items rely on the temperature, weight, habitation time and warmth misfortunes. Anyway following general comments can be made about them. Up to the temperature of 200^0C just water is driven off. Between 200°C to 280°C carbon dioxide, acidic corrosive and water are emitted.

The genuine pyrolysis, which happens between 280°C to 500°C, delivers enormous amounts of tar and gases containing carbon dioxide. Other than light tars, some methyl liquor is additionally framed. Between 500°C to 700°C the gas creation is little and contains hydrogen.

3.3. Combustion Zone (Oxidation Zone)

The flammable substance of a strong fuel is typically made out of components carbon, hydrogen and oxygen. Incomplete ignition carbon dioxide is acquired from the carbon in fuel and water is gotten from the hydrogen, normally as steam. The burning response is exothermic and yields a hypothetical oxidation temperature of 1450°C. The primary responses, in this manner, are

$$C + O_2 = CO_2 \text{ (+ 392.5 MJ/kg mole)} \quad (1)$$

$$2H_2 + O_2 = 2H_2O \text{ (- 243 MJ/kg mole)} \quad (2)$$

3.4. Reduction Zone

The results of fractional burning (water, carbon dioxide and un-combusted in part split pyrolysis items) presently go through an intensely hot charcoal bed where the accompanying decrease responses happen.

$$C + CO = 2CO \text{ (- 165 MJ/kg mole)} \quad (3)$$

$$C + H_2O = CO + H_2 \text{ (- 122.9 MJ/kg mole)} \quad (4)$$

$$CO + H_2O = CO + H_2 \text{ (+ 42.2 MJ/kg mole)} \quad (5)$$

$$C + 2H_2 = CH_4 \text{ (+ 75.3 MJ/kg mole)} \quad (6)$$

$$CO_2 + H_2 = CO + H_2O \text{ (- 42.5 MJ/kg mole)} \quad (7)$$

Responses (3) and (4) are fundamental decrease responses and being endothermic have the ability to lessen gas temperature. Thus the temperatures in the decrease zone are regularly 800–1000°C. Lower the decrease zone temperature (~700–80°C), lower is the calorific estimation of gas.

4. EXPERIMENTAL DESIGN

Figure 11: Fabrication of Updraft Type Gasification Process.

The response chamber is structured with the length of 60 cm and width of 35 cm at the 1.5 mm thickness of the iron sheet. The section association to the response chamber to twister channel is with the length of 60cm. The typhoon channel structured 30 cm stature and width of 20 cm, the cone state of littler dia of 4 cm and its bigger dia 20 cm. Furthermore, adequate separation kept up between the twister channel and scrubber purifier tank at the length of 40 cm and is associated with the assistance of G. I funnels. The scrubber tank structured at 40 cm stature and its diameter 20 cm. However, we measure the gasification proficiency and gas creation rate, gas stream rate with the assistance of gas stream controller and weight check as setup roar figure.

4.1. Experimental Procedure

The test method comprised of the accompanying advances. Initially, the gasification reactor was warmed to800 ^{0}c and once the temperature was balanced out the primary stage pyrolysis reactor was warmed to 600 ^{0}c with the warming rang of 40 ^{0}c/min. Since the biomass and plastic waste material decay begin at the response chamber at a higher temperature. The response chamber is recorded with the biomass material and plastic waste material at a reasonable extent and by providing warmth there will be a separation of particles to advance the smoke sort of the gas. This is gone through the typhoon channel and there is a capacity to evacuate the tar content in the gas with the assistance of twirling movement of violent wind channel. After which the gas is gone through the scrubber kind of purifier tank so as to expel the residue molecule in gas content. At long last, the biomass and plastic waste material is given that contains the carbon monoxide and hydrogen which is known as a maker gas.

Figure 12: Experimental Setup of Updraft Gasifiers.

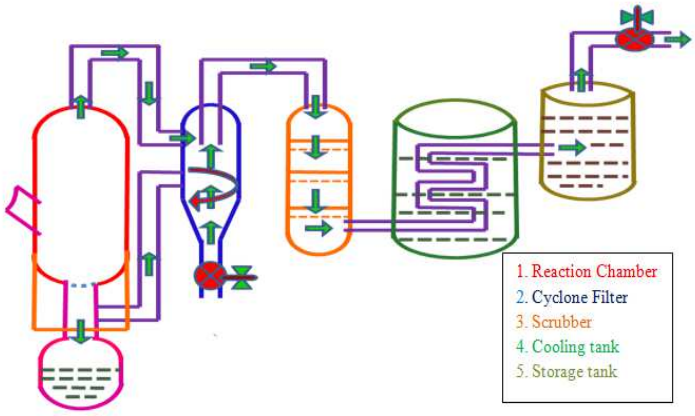

Figure 13: Line Diagram of Updraft Type Gasifier.

4.2. Components of the Manufactured Gasifier

4.2.1. Reaction Chamber

The Reactor is encased chamber on a chamber tank to warm the wood or any material with burning temperatures yet without full ignition. Its need great wind current at the base and need a segment to evacuate fiery debris additionally at the base. This is accomplished by reacting the material at high temperatures without ignition with a controlled amount of oxygen and steam the subsequent gas blend is called syngas or e maker gas and is itself a fuel.

4.2.2. Cyclone Channel

The cyclonic division is a technique for expelling particulates from an air, gas or fluid stream, without the utilization of channels, through vortex detachment. When expelling particulate issue from fluid, a hydro violent wind is utilized while from gas, a gas twister is utilized. Rotational impacts and gravity are utilized to isolate blends of solids and liquids. The strategy can likewise be utilized to separate fine beads of fluid from a vaporous stream.

4.2.2. Scrubber System

Scrubber frameworks are differing that can be utilized to expel a few particulates and gases from streams. Scrubbers are one of the essential gadgets that control vaporous emanations, particularly vent gases.

Figure 14: Reaction Chamber.

Figure 15: Cyclone Channel.

Figure 16

Figure 17: Gas stream Meter. **Figure 18: Pressure Gauge.** **Figure 19: Control Valve.**

4.2.3. Gas Stream Meter

A gas meter is a particular stream meter, used to gauge the volume of fuel gases, for example, flammable gas and melted oil gas. Gas meters are utilized at private, business, and modern structures that expend fuel gas provided by a gas utility. Gases are more hard to gauge than fluids, in light of the fact that deliberate volumes are profoundly influenced by temperature and weight. Gas meters measure a characterized volume, paying little heed to the pressurized amount or nature of the gas coursing through the meter. Temperature, pressure, and warming worth pay must be made to gauge genuine sum and estimation of gas travelling through a meter.

4.2.4. Pressure Gauge

Weight check used to quantify weights lower than the encompassing barometrical weight, which is set as the zero points, in negative qualities (-15psig or-760 mmHg equivalents complete vacuum). Most checks measure weight in respect to air weight as the zero point, so this type of perusing is basically alluded to measure weight.

4.2.5. Control Valve

Control valves direct the progression of a fluid or gas by opening or shutting inner sections. They structure some portion of a control a procedure. The control valves react to directions from the controller and change the inward openings in like manner. The valve stem modifying the size of the entry and this expansion diminishes or holds consistent the stream.

5. RESULTS AND DISCUSSIONS

The examination is led with various biomass material are Coconut shell, Castor husk, Sugar stick bagasse, Rice husk and Plastic waste material individually. The parameters of the gasification process for all previously mentioned biomass material are determined and postponed underneath the appeared table 1and table 2.

Table 1: Results for Gasification Process Parameters

Sl. No	Material Description	Material Quantity (Mj/m^3) (Hr)	Cv of Biomass Operating Pressure in Time (Bar)	Gas Flow Rate in (m^3/Hr)
1	Coconut shell	1.8	1.8	1.08
2	Sugar cane	17.4	1.7	1.02
3	Castor husk	16.16	1.5	0.9
4	Rice Husk & Plastic	16.5	1.2	0.6

Table 2: Results for Gasification Process Parameters

CV of Producer Gas (Mj/M^3)	Specific Gas Production (M^3/Hr/M^2)	Quantity of Gas Rate Produced in (Kg)	Gassification Inefficiency (%)	Surface Zone Temperature (^{0}C)
5.2	5.14 Reduction Zone Pyrolsis Zone Drying Zone	1.83 423 254 187	85.6	Combustion Zone = 755
5.15	4.8 Reduction Zone Pyrolsis Zone Drying Zone	1.733 422 254 186	77.64	Combustion Zone = 748
5.05	4.2 Reduction Zone Pyrolsis Zone Drying Zone	1.529 420 250 180	62.38	Combustion Zone = 750
4.6	2.85 Reduction Zone Pyrolsis Zone Drying Zone	1.227 400 250 180	46.41	Combustion Zone = 720

5.1. Graphical Representation

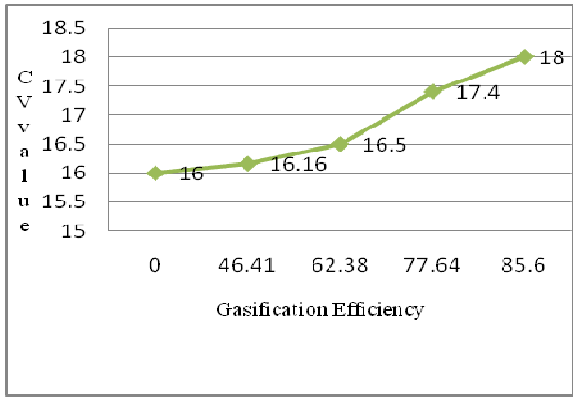

Figure 20: Cv Value (vs) Gasification Efficiency.

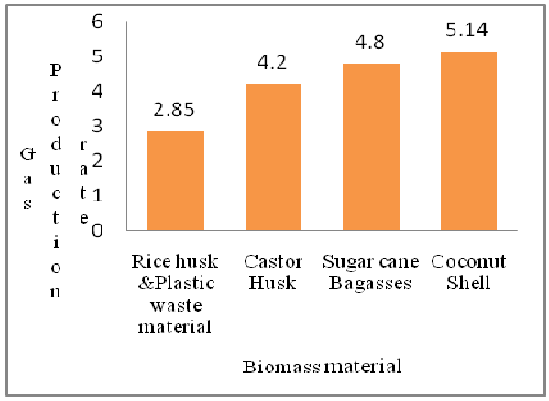

Figure 21: Gas Production (vs) Biomass Material.

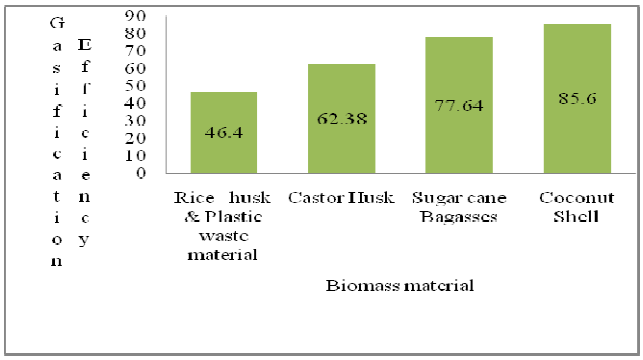

Figure 22: Gasification Efficiency (vs) Biomass Material.

6. CONCLUSIONS

- An Experiment is directed on Four Diverse Material; Coconut Shell, Sugar Cane Bagasse, Castor Husk, Rice husk and Plastic Waste Material, by utilizing manufactured Updraft type Gasifier and their Efficiencies, Gas creation rate, gas stream rate and calorific esteem are determined.
- Coconut Shell Material is given to the High gas Production rate (5.14 $m^3/hr/m^2$), Gasification Efficiency (85.6%) and gas flow rate (1.08 m^3/hr).
- Rice Husk and Plastic Waste Material given the Low Gas Production rate(2.85 m3/hr/m2) Gasification Efficiency (46.4%) and Gas flow rate (0.6 m^3/hr) when compared to the other material because the combination of Plastic contains the more carbon percentage level and high tar content and also steam production rate is high.

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